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Effects of Specific Strength Training on Neck Range of Motion, Strength and Pain in Chronic Neck Pain Patients.

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Introduction:

Neck pain is one of the most common and painful musculoskeletal conditions, with considerable costs for the individual and the society Prevalence ranges from 6% to 22% and up to 38% in elderly population, while across life span prevalence ranges from 14,2 % to 71% (Fejer R. et al., 2005). Neck pain is particularly prevalent in office workers due to the increase in the use of computers (Sillanpää J. et al., 2003) (Janwantanakul P. et al., 2007), such as the duration of computer use, sustained awkward posture, and prolonged working with a visual display unit (**VDU**) (Brandt LPA. et al., 2004) (Straker LM, Mekhora K, 2000). The main problems in patients with chronic neck pain are cervical dysfunction and abnormal sensory processing, reduced neck mobility and stability, impaired cervicocephalic kinesthetic sense, in addition to local and possibly generalized pain (Nijs J. et al., 2009; Falla, 2004). Cervical dysfunction is characterized by reduced function of the deep stabilizing muscles of the neck (Hansen I R. et al., 2011). Besides chronic neck pain, patients may develop chronic pain followed by sensitization of the nervous system (Kasch H. et al., 2008) (Cagnie B. et al., 2006).

The most significant contributing factor in chronic neck pain is fatigue caused by the prolonged neck muscle activation, which is essential to hold the head in various positions (Ylinen J. et al., 2004). Moreover Recent studies have shown that the activities of the deep cervical flexor muscles are impaired in persons with neck pain (Borisut S. et al., 2013).Moreover, several studies have reported significantly lower maximal isometric strength of both the cervical flexors and extensors in patients with chronic neck pain compared to healthy controls (Barton PM. and Hayes KC., 1996) (Chiu TT. et al., 2002) and one study found weakness of the neck rotator muscles (Ylinen J. et al., 2003).

Therefore, neck strength training has been one of the most important means in seeking cure for neck pain. In addition to gaining neck muscle strength, neck strength training has been shown to be effective in reducing neck pain and the disability associated with it (Bronfort G. et al., 2001) (Chiu TT. et al., 2005) (Falla D. et al., 2007).

Neck pain is a significant societal burden due to its high prevalence and healthcare costs. While physical activity can help to manage other forms of chronic musculoskeletal pain, little data exists on the relationship between physical activity and neck pain (Janice Cheung et. al. 2013).

Therefore, the purpose of this study was to evaluate the effects of a specific strength training program for the deep cervical flexor muscles in reducing the pain level located as well as on perceived pain and disability of patients with chronic neck pain.

Subjects and Methods

Thirty-three male subjects participated in the study. They were divided into two groups; the experimental group consisted of 19 patients. The control group consisted of 13 patients. All participants were informed about the purpose and content of the study and they were given a form to fill in order to participate in this study. The collectives were matched by age, height and weight, which is presented in Table 1.

Table 1.
Means and Standard Deviations of Characteristics of subjects at the baseline.

Characteristics	Experimental Group (n = 19)	Control Group (n = 13)	Variance	Values
Age (year)	43.89 (±3.02)	43.54 (±2.70)	0.36	0.34
Height (cm)	177.16 (±2.75)	177.85 (±3.60)	0.69-	0.61
Weight (kg)	94.05 (±6.28)	95.38 (±6.01)	1.33-	0.60

All of them had a history of neck pain lasting for more than 6 months. They worked with a computer at least 4 - 6 hours during the week. The pain level at the time of examination exceeded between 4 -7 on a visual analogue scale of 0 –10. Subjects were excluded if they had neck or shoulder pain from non- musculoskeletal causes, or demonstrated neurological signs at the time of examination.All subjects received verbal and written information about the study and all gave their written consent before entering the study.

Visual analogue scale (**VAS**) has been used to assess pain (Falla D. et al., 2006) (Jull GA. et al., 2009) (Borisut S. et al., 2013). The Neck Disability Index (**NDI**) was used in this study for measuring self-rated disability due to neck pain. The NDI is a valid, reliable, and sensitive tool for measuring changes in pain and disability in patients with neck pain (Vernon, 2008) (Luckumnueporn, 2007) (National Health and Medical Research Council, 2008).

The maximum mobility of the cervical spine was defined as the maximum amplitude which the patient achieved actively in an upright sitting standardized position and was measured with **Gollehon Extendable Goniometer (manufacturer name and address)**. The maximal strength of the cervical spine was measured by **"Dynamometer"** to test the isometric neck muscle strength with patients seated in a standard position, generating force by backward bending, lateral bending and left and right rotations, and methodology used in the reliability study reported earlier (Petri K Salo et. al. 2010).

Experimental procedure

The program consisted of a progressive resistance exercise regimen for the neck muscles, especially the superficial neck flexor and extensor muscles. Elastic band (**Thera-Band**) of different resistances (green, blue, and black) were used. Furthermore, exercise program included the active and passive cervical stretching exercises (Flexion, Extension, Left Lateral Rotation, Right Lateral Rotation, Left Lateral Flexion, Right Lateral Flexion), slowly moving the neck through the total range of motion avoiding discomfort or pain.

Statistical analysis

Paired Samples Test and Independent Samples *t* Test were performed using SPSS 18 statistical software for windows (SPSS Inc., Chicago, IL, USA). The data were reported as mean ± standard deviations (SDs).

Training program

The program included two phases with 4 and 8 weeks respectively, as suggested for untrained individuals. (McArdle W. et al., 1996.) (Borisut S. et al., 2013). Each phase included three sessions per week (approx. 45 - 60 min for each). The suggested program was conducted individually for all subjects.

Phase one

In the first six sessions (two weeks), treatments began with massage (about 30 min sweeping technique) of work to upper back, shoulders and neck (Andrade CK and Clifford P., 2008). It focused on the importance of massage usage as a treatment option showed to be more effective at decreasing the neck pain (Sherman K. J. et al., 2009). The final time interval of treatment concentrated on Self-Stretching "active cervical range of motion".

For the rest of this phase (six sessions), **Low Intensity of Interval Training** was used. The intensity of exercise used in this way no more than medium intensity 50 to 70% of the individual maximum level, repetition of each exercise for approx. 10 times for three sets, and the rest periods ranging from 60 seconds to 120 seconds (Erlangen, 2003). The sessions consisted of 5 min. stretching exercises followed /with low-load strength exercises. All patients performed 3 sets with one minute rest interval between sets, for approx. 40-50min in total.

Phase two

All strength exercise in this phase consisted of a low load exercise with resistance adjusted by using the elastic band of different resistances. Each session in the suggested program began and ended with an assessment of the patient's progress by using the VAS, just to evaluate the pain level (pre- and post-treatment each session). Measurements for all suggested exercises (for each subject) must be carried out to determine the maximum load for strength training.

The following table shows the distribution of the volume, intensity and the rest interval throughout the suggested program.

Table (2)

Phase	week	Sessions	load intensity	rest interval between sets
One	1	1 , 2 and 3	massage (sweeping technique) & Self-Stretching "active cervical range of motion"	
	2	4, 5 and 6		
	3	7, 8 and 9	50 % of maximum repetition	1 min
	4	10, 11 and 12		
Two	5	13, 14 and 15	55 % of maximum repetition	1 min
	6	16, 17 and 18		
	7	19, 20 and 21	60 % of maximum repetition	1 min
	8	22, 23 and 24		
	9	25, 26, and 27	65 % of maximum repetition	1.30 min
	10	28, 29 and 30		
	11	31, 32 and 33	70 % of maximum repetition	1.30 min
	12	34, 35 and 36		

Results

Patients were assessed for maximal isometric neck strength in the neutral position, range of motion (**ROM**) in flexion, extension, VAS scores and NDI of each group before the suggested exercise program. No difference has been shown according to the data in table 3 at the baseline (p=0.005).

After 12 weeks of exercise program data analysis showed that there were significant differences except the VAS scores between the experimental and control Group (**T Independent Samples *t* Test** = 7.92). Similarly for NDI scores, main effects analysis of time (before and after 12 week) showed that there were significant differences (**T Independent Samples Test** = 7.08).

Main effects analysis showed that there were significant differences in ROM (between the range of 6.62 and 9.44) and cervical strength after the exercise between the groups (between the range of 4.91 and 8.04) Table 3.

Table 3.

Means and Standard Deviations of Cervical Range of Motion (ROM), Cervical Strength, Neck pain intensity (VAS) and Neck Disability Index (NDI) at the baseline and 12 weeks.

			Baseline			12 weeks		
			Ex-group (n=19)	Control group (n=13)	Independent Samples Test	Ex-group (n=19)	Control group (n=13)	Independent Samples Test
Range of Motion (ROM)	cervical flexion	degrees	49.42 (±1.57)	49.85 (±1.41)	0.78	54.63 (±1.38)	49.54 (±2.33)	**7.76
	cervical extension		49.26 (±1.94)	49.08 (±1.89)	0.27	54.37 (±1.46)	48.85 (±1.99)	**9.06
	lateral flexion (right side)		41.26 (±2.84)	40.85 (±2.94)	0.40	48.37 (±1.64)	39.31 (±3.71)	**9.44
	lateral flexion (left side)		40.58 (±2.48)	40.54 (±2.44)	0.05	47.32 (±2.58)	39.92 (±1.80)	**8.92

			Baseline			12 weeks		
			Ex-group (n=19)	Control group (n=13)	Independent Samples Test	Ex-group (n=19)	Control group (n=13)	Independent Samples Test
	Maximal rotation right		60.89 (±1.79)	60.85 (±1.91)	0.07	67.11 (±2.16)	61.46 (±2.54)	**6.77
	Maximal rotation left		60.26 (±2.42)	60.38 (±2.53)	0.14	66.79 (±2.46)	60.15 (±3.21)	**6.62
Cervical Strength	Flexion torque	LBS	19.42 (±1.54)	19.23 (±1.59)	0.34	23.79 (±1.51)	19.31 (±1.60)	**8.04
	Extension torque		31.68 (±1.95)	31.92 (±2.10)	0.33	35.63 (±2.29)	31.23 (±2.01)	**5.61
	Lateral flexion right torque		23.32 (±3.27)	24.15 (±3.26)	0.71	29.53 (±2.41)	24.77 (±3.06)	**4.91
	Lateral flexion left torque		22.58 (±3.15)	23.08 (±3.15)	0.44	29.00 (±2.40)	24.00 (±1.22)	**6.89
VAS	Neck pain intensity	score	5.74 (±0.81)	5.38 (±0.77)	1.24	2.79 (±0.79)	5.46 (±1.13)	**7.92
NDI	Neck Disability Index	score	29.96 (±4.51)	31.56 (±5.14)	1.73	18.41 (±4.94)	33.86 (±5.04)	**7.08

(*p0.005 = 2.032)

Discussion

The results of this study support the recommendation to use strength exercises for the cervical muscles as treatment interventions for patients with chronic neck pain (Randlov A. et al., 1998) (Hagberg M. et al., 2000). The results were also in agreement with previous studies that demonstrated that pain can be reduced by strength training (Randlov A. et al., 1998) (Hagberg M. et al., 2000) (Waling K. et al., 2000) (Ylinen J. et al., 2003) (Falla D. et al., 2006) (Jull GA. et al., 2009) (Borisut S. et al., 2013). Moreover, general exercises like stretching exercise (active and passive cervical Range Of Motion) have been shown to decrease neck symptoms. (Ylinen J. et al., 2003).

In the present study, the neck pain and disability index significantly improved after 12 weeks of exercise intervention in experimental group. This indicates that exercise program caused the changes in VAS and NDI score of patients who had chronic neck pain. This result was in agreement with previous studies (Falla D. et al., 2006) (Jull GA. et al., 2009) (Borisut S. et al., 2013), which showed the same trend of decrease in VAS and NDI score after having the suggested exercise program.

The reductions in pain and neck disability were significantly different among the experimental – and control group. There was a trend of increased in NDI and VAS score in the control group, which performed no exercise program.

The result of Range of Motion (**ROM**) showed the differences between before and after the training program in the experimental-group, but there was no significant difference between before and after the intervention in the control group. This result was consistent to previous study (Borisut S. et al., 2013)

In experimental- group, the benefits might have improved the deep cervical flexor muscle. Therefore, the decrease in of cervical muscle activation seen in this study might have been effected on the neck extensor, superficial flexor and deep cervical flexor muscles.

This study provided evidence of an exercise effect on the pain levels, NDI scores and ROM values of subjects who performed specific strength and stretching exercise for 12 weeks. The results of this study indicate that pain levels and NDI scores decreased after the suggested exercise program.

A limitation of this study is that it is not possible to generalize the results due to relatively small sample size. Further studies are warranted to investigate the effect of longer strength training regimens. Moreover, the severity of neck pain such as mild, moderate or severe pain may influence the muscle activities after exercise program. As such, it is recommended to deal with such kind of studies among large number of samples. And there should be follow-up studies for tracing the impact of this studies on the long run.

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